A vane pump or motor

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Abstract of **GB2322913**

In a vane pump or a motor suitable for use as an engine, for example an internal combustion engine, a vaned rotor 2 is mounted eccentrically in an annular stator 4 provided with a substantially freely rotatable annular wall liner 12. In use the wall liner 12 rotates relative to said stator, such that the movement of the vane sealing portions relative to the wall liner is reduced in comparison with movement of the vane sealing portions relative to the stator. The wear of the vane sealing portions is thereby reduced.

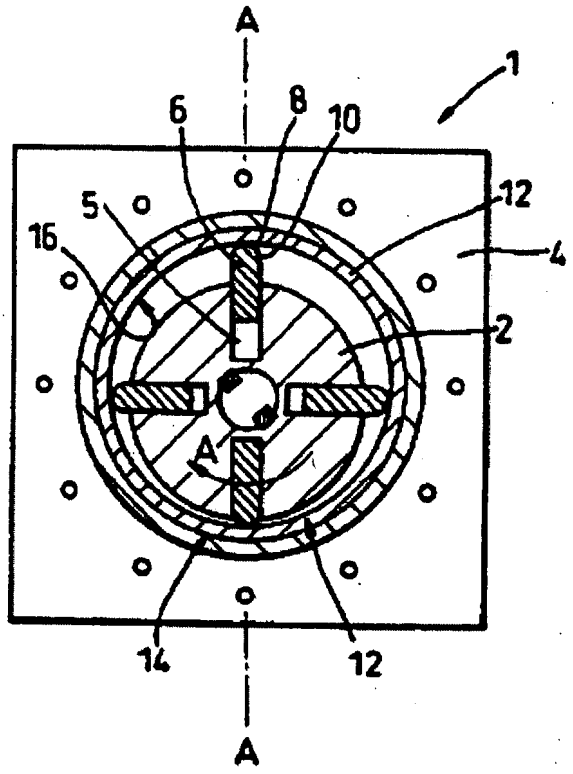

Fig. 1

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GB 2249139 A GB 2143279 A GB 2140088 A
GB 2074653 A GB 0954442 A US 4479763 A

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(54) Abstract Title
A vane pump or motor

(57) In a vane pump or a motor suitable for use as an engine, for example an internal combustion engine, a vaned rotor 2 is mounted eccentrically in an annular stator 4 provided with a substantially freely rotatable annular wall liner 12. In use the wall liner 12 rotates relative to said stator, such that the movement of the vane sealing portions relative to the wall liner is reduced in comparison with movement of the vane sealing portions relative to the stator. The wear of the vane sealing portions is thereby reduced.

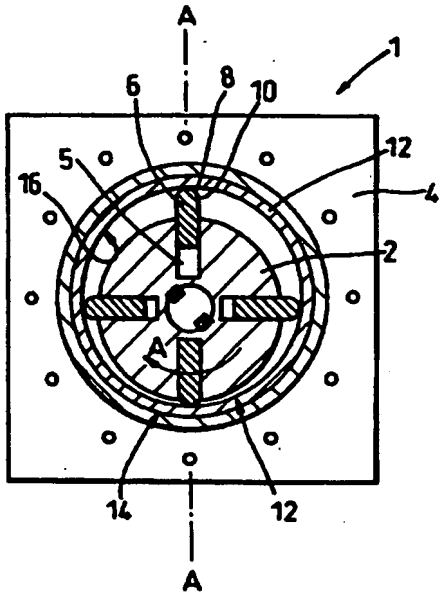

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

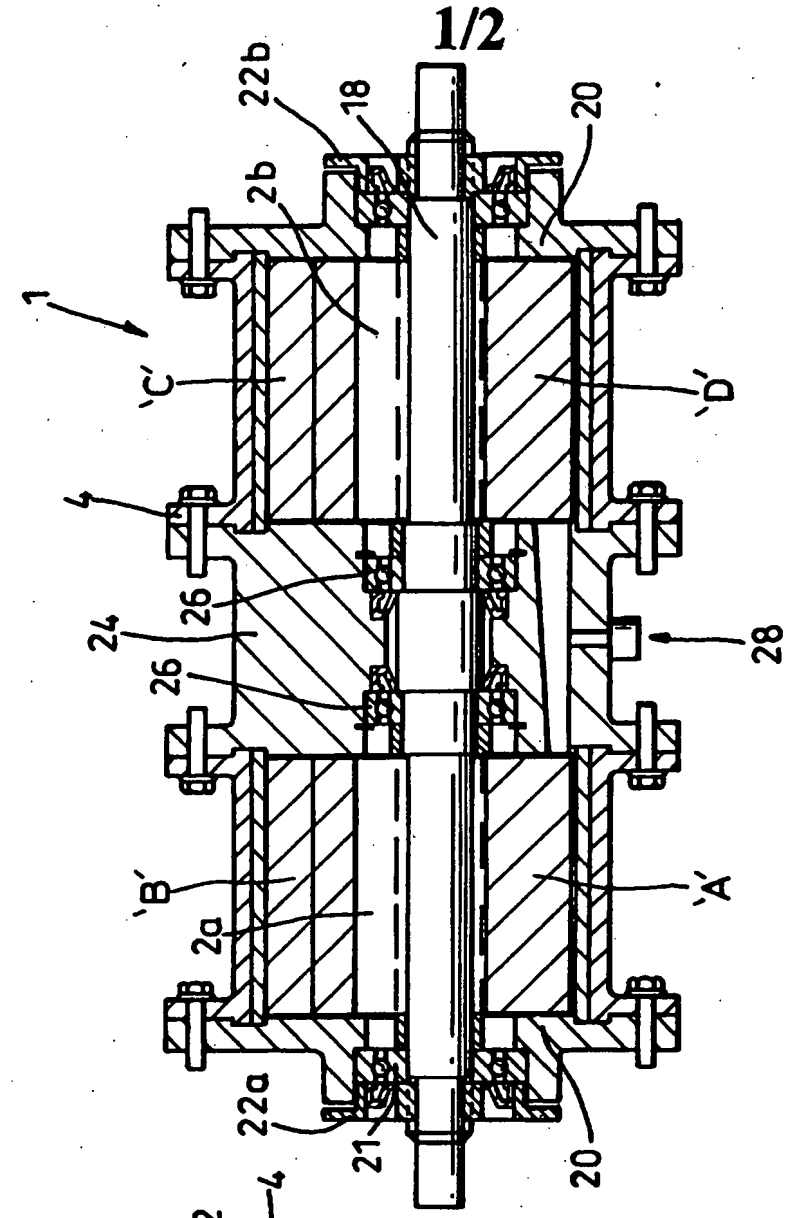
22b
18
20
2b
1
'C'
'D'
4
26
24
26
28
'B'
'A'
2a
22a
21
20

Fig. 2

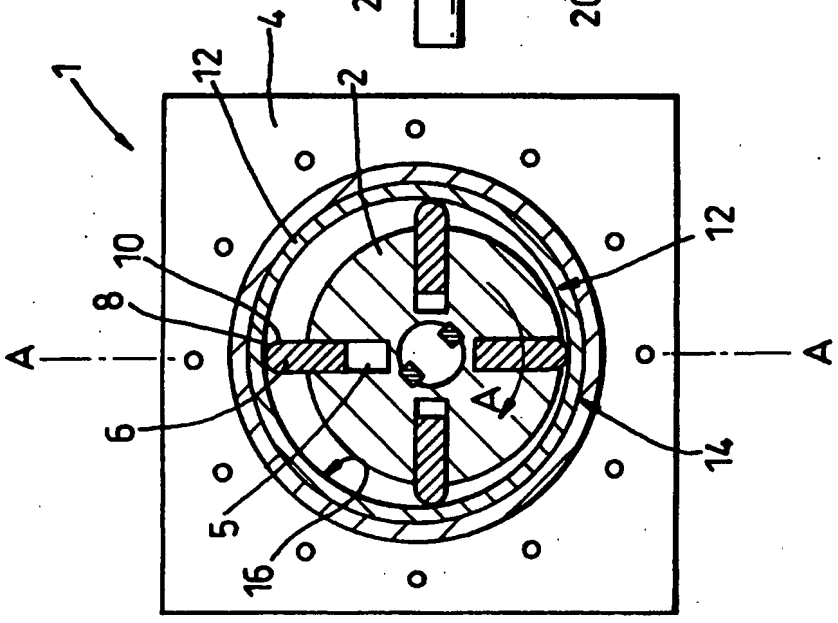
1
4
12
2
10
8
A
A
12
6
14
5
16

Fig. 1

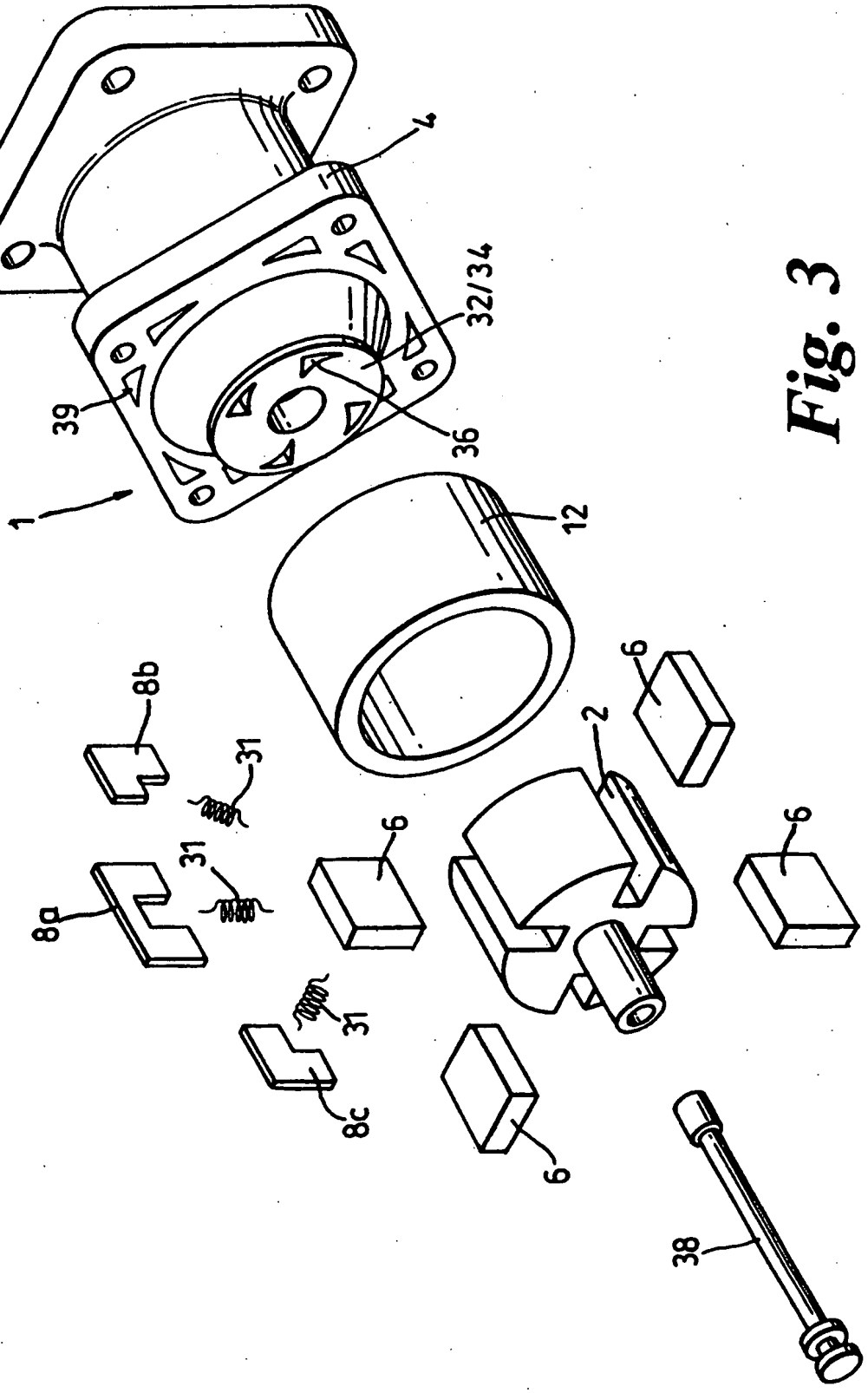

Fig. 3

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VANE PUMP/MOTOR

The present invention relates to a vane (or roller) motor or vane (or roller) pump.

Vane pumps have been known for a great many years and have many applications such as a vacuum or oil pump or as a compressor. Vane engines are known also. As used herein the term vane pump encompasses vane motors and engines and the term vane includes roller vanes.

A vane pump comprises a slotted rotor mounted eccentrically in an annular stator and vanes which slide in and out of the rotor slots and which divide up a crescent-shaped fluid space into variable volumes. Such pumps are known also as variable volume pumps or motors.

Such vane pumps have always had an inherent problem and that relates to the sealing achieved by the tip of the vane on the inside surface of the stator as it rotates therein and the wear rate thereof. Various approaches to overcome the sealing problem have been proposed such as for example using a soft tip portion. The use of a soft tip whilst providing improved sealing characteristics results though in increased wear. On the other hand the use of a hard tip gives increased life but at the expense of reduced sealing characteristics.

It is an object of the present invention to avoid or minimise one or more of the foregoing disadvantages.

The present invention relates to a vane pump or motor device comprising a rotor mounted eccentrically in an annular stator, said rotor having a plurality of vane slots in which are slidably mounted vanes having sealing portions at radially outward edges thereof characterised in that an annular wall liner means is mounted in said stator and has an inner wall surface for sealing engagement with said vane sealing portions, said wall liner means being mounted in said stator for substantially free rotation relative thereto whereby in use of the device said wall liner means rotates relative to said stator and the movement of said vane sealing portions relative to said liner wall surface in sealing engagement therewith is substantially reduced in comparison to movement of said vane sealing portions relative to said stator thereby to decrease wearing of said vane sealing portions.

Thus with a vane pump or motor device according to the present invention substantially reduced rates of wear of the sealing portions of vanes in a vane pump or vane motor can be realised and improved sealing can be achieved than with conventional vane pumps or motors.

Preferably said wall liner means is mounted in said stator on bearing means for substantially free rotation thereof. Said bearing means may be in the form of ball or

roller bearings or preferably the inner annular wall means of the stator is in the form of a first bearing surface and the outer annular wall means of said wall liner means is in the form of a second bearing surface, said surfaces being formed and arranged for said substantially free rotation of said wall liner means relative to said stator.

Desirably said bearing means is provided with a lubricant such as for example a mineral or synthetic oil having desirably a low viscosity so as to reduce drag between the wall liner means and the stator during rotation thereof. Preferably there is provided lubricant recirculation means such as for example a pump to replace more or less continuously lubricant between the wall liner means and the stator. Advantageously there is provided in said lubricant recirculation means cooling means such as for example a radiator or other heat dissipating means.

Preferably said slidably mounted vanes have sealing portions at respective side edges thereof for sealing engagement with respective side end plates on said stator. Preferably said radially outward sealing portions and desirably said side sealing portions of said vanes are provided with biasing means such as for example a spring for urging the tip portions into sealing engagement with the annular wall liner means and desirably said side sealing portions into sealing engagement with said respective end plates. Most desirably said radially outer sealing portion overlaps with each said side sealing portion.

Preferably said side end plates are provided with working fluid inlet and outlet means. Desirably said inlet and/or outlet means are provided with valve means, preferably variably controllable valve means, to control the passage of working fluid into and out of the pump or motor device according to the invention. Preferably said valve means is in the form of a disc having at least one aperture forming a said inlet or outlet means. Desirably said disc valve means is mounted on a valve means control shaft running through the centre of the rotor.

Any suitable number of vanes may be used from for example two to eight or more vanes. The number of vanes will be determined by the particular application of the motor or pump and will be known to the person skilled in the art. Desirably for use as an engine, advantageously an internal combustion engine, four vanes are provided on said rotor so defining four variable volume fluid chambers. Desirably where said motor device according to the invention is to be used as an engine said four vanes define respectively the induction, compression, power and exhaust stages corresponding to those of a typical four stage internal combustion engine. Desirably two or more motor devices according to the invention may be arranged in series such that a first motor acts to give the induction and compression stages and a second motor acts to receive compressed fluid and to give the power and exhaust stages.

For use as an engine there is provided fuel injector means and/or fuel igniting means such as a spark plug or compression ignition means.

It will be understood that said sealing portions of said vanes at said radially outward edges thereof will because of the eccentricity of rotation have different angular speeds of rotation. Accordingly each vane will exert a different driving force on said annular wall liner means though the combination of driving forces of said vanes will cause said annular wall liner means to rotate desirably at least as fast as said rotor or such that the speed of rotation of the wall liner means is maximised with respect to the speed of the rotor. In practice though said wall liner means will rotate at approximately 70-80% of the speed of rotation of the rotor in some applications. With alternative arrangements of the present invention it is possible for the wall liner means to be leading the vanes.

Various different materials and methods of manufacture may be used depending on for example whether the motor device according to the invention is to act as an engine or a pump. Thus for example in use as an internal combustion engine there might be used steels or other alloy components and ceramic sealing portions capable of sustaining high temperatures and pressures. For use in for example a low pressure water pump there might be used plastics materials and for example rubber or other resilient material sealing

portions. Such materials will be known to the person skilled in the art.

Further preferred features and advantages of the present invention will appear from the following detailed description given by way of example of some preferred embodiments illustrated with reference to the accompanying drawings, in which:

Fig 1 is an end view through a section of a vane pump or motor device according to the invention;

Fig 2 is a side view through a section of the vane pump or motor device shown in Fig 1; and

Fig 3 is an exploded perspective view of the components of the vane pump or motor device according to the invention.

A motor, as shown in Fig 1 of the drawings and indicated by the reference number 1, comprises a rotor 2 mounted eccentrically in an annual stator body 4. The rotor 2 has four vane slots 5 in which are slidably mounted vanes 6, each vane 6 having a sealing tip 8 at its radially outward edge 10. The motor 1 is characterised in that an annular wall liner 12 is mounted in the stator 4 for sealing engagement with the sealing tips 8.

In more detail, the wall liner 12 is mounted in the stator 4 on a film of lubricating oil 14 so that it may rotate within and relative to the stator 4 more or less freely.

In operation of the motor 1, the wall liner 14 will, at least initially, remain static within the stator 4, and as the rotor 2 and the vanes 6 start to rotate, in the direction of arrow "A", the sealing engagement and hence friction of the sealing tips 8 on the side surface 16 of the wall liner 12 exert a torque or driving force on the wall liner 12 such that the wall liner 12 starts to rotate with the rotor 2 and vanes 6. It will be appreciated that as the centres of rotation of the rotor 2 and the wall liner 12 are offset they will each have different speeds and that the angular speed of each of the four sealing tips 8 is different. The combined driving effect of the sealing tips 8 on the wall liner 12 results in the wall liner 12 rotating at approximately 75% of the speed of rotation of the rotor 2. It will be appreciated and understood therefore that as the wiping movement of the sealing tips 8 relative to the stator and in the case of the invention the inner wall 16 of the rotating wall liner 12 is substantially reduced, the wear of the sealing tips 8 is substantially decreased than in comparison with a conventional vane motor where the relative motion or wiping movement of the rotating sealing tip on the stationary inner wall of the stator is at a maximum.

Turning to Fig 2 of the drawings which shows a side sectional view along lines A-A of the motor shown in Fig 1. The motor 1 actually comprises two spaced apart rotors 2a,2b mounted on a common drive shaft 18 in the stator 4. End plates 20 including bearing 21 housings 22a,22b to support the drive shaft 18. The centre portion 24 of the stator 4 contains bearings 26 for supporting the centre of the drive shaft 18. The centre portion 24 contains also any necessary valve mechanisms (not shown here) and a fuel injector 28 and a spark plug (not shown).

In principle of operation the motor operates as follows:-

Air (or optionally a fuel/air mixture) is drawn into the motor 1 through a port with a valve mechanism into the induction portion of the motor, corresponding to letter "A" on Fig 2. As the rotor and vanes rotate the air is compressed in the deceasing volume defined by the rotor 2, the vanes 6 and the wall liner 12, corresponding to the letter "B" in Fig 2. The compressed air then passes through a port with a valve mechanism (not shown) in the centre portion 24 of the stator 4 and is mixed with fuel from the fuel injector 28 and passes into the second rotor 2b where it is ignited by a spark plug (not shown) and thereby expands rapidly (corresponding to letter "C") while driving the rotor 2 and hence the driveshaft within the stator 4. The combusted fuel/air mix is then exhausted out of the motor under the driving action of the vanes (corresponding to letter "D").

Fig 3 shows in exploded format the key component parts described above with reference to Figs 1 and 2 of the drawings. In more detail and as will be seen from Fig 3 the sealing tips 8 on the vanes 6 comprise a centre seal tip 8a, which is biased outwardly by springs 31 from the vane 6 into sealing engagement with the wall liner 12. The vanes also have spaced apart side seal tips 8b, 8c which are also biased outwardly by springs 31 into sealing engagement with the end plates 20 of the motor (see Fig 2), on one side thereof and into sealing engagement with a rotary disc valve assembly 32 on the other inner side of the motor 1.

In more detail the disc valve assembly 32 comprises an annular disc 34 which has four apertures 36. The disc 34 is controlled by a valve control shaft 38 for timing the alignment of the apertures with the inlet and outlet ports of the motor so as to permit the inlet and exhaust of mixture into and out of the motor.

It will be appreciated that various modifications may be made to the above described embodiments without departing from the scope of the present invention. Thus for example and as shown in Fig 3 the stator 4 may be provided with an arrangement of coolant circulation passages 39 to dissipate heat generated by the motor 1.

CLAIMS

1 A vane pump or motor device comprising a rotor mounted eccentrically in an annular stator, said rotor having a plurality of vane slots in which are slidably mounted vanes having sealing portions at radially outward edges thereof characterised in that an annular wall liner means is mounted in said stator and has an inner wall surface for sealing engagement with said vane sealing portions, said wall liner means being mounted in said stator for substantially free rotation relative thereto whereby in use of the device said wall liner means rotates relative to said stator and the movement of said vane sealing portions relative to said liner wall surface in sealing engagement therewith is substantially reduced in comparison to movement of said vane sealing portions relative to said stator thereby to decrease wearing of said vane sealing portions.

2 A vane pump or motor device as claimed in claim 1, wherein said wall liner means is mounted in said stator on bearing means for substantially free rotation thereof.

3 A vane pump or motor device as claimed in claim 2, wherein said bearing means are in the form of ball or roller bearings.

4 A vane pump or motor device as claimed in any of claims 1, 2 or 3, wherein the inner annular wall means of the stator is in the form of a first bearing surface and the

outer annular wall means of said wall liner means is in the form of a second bearing surface, said surfaces being formed and arranged for said substantially free rotation of said wall liner means relative to said stator.

5 A vane pump or motor device as claimed in claim 4, wherein said bearing means is provided with a lubricant having desirably a low viscosity so as to reduce drag between the wall liner means and the stator during rotation thereof.

6 A vane pump or motor device as claimed in claim 1, wherein the lubricant is a mineral or synthetic oil.

7 A vane pump or motor device as claimed in claim 5 or 6, wherein there is provided lubricant recirculation means such as for example a pump to replace more or less continuously lubricant between the wall liner means and the stator.

8 A vane pump or motor device as claimed in claim 7, wherein the lubricant recirculation means is a pump.

9 A vane pump or motor device as claimed in claim 7 or 8, wherein there is provided in said lubricant recirculation means cooling means.

10 A vane pump or motor device as claimed in claim 9, wherein the cooling means is a radiator or other heat dissipating means.

11 A vane pump or motor device as claimed in any preceding claim, wherein said slidably mounted vanes have sealing portions at respective side edges thereof for sealing engagement with respective side end plates on said stator.

12 A vane pump or motor device as claimed in any one of the preceding claims, wherein said radially outward sealing portions are provided with biasing means for urging the tip portions into sealing engagement with the annular wall liner means.

13 A vane pump or motor device as claimed in claim 12 or 13, wherein said radially outward sealing portions and/or said side sealing portions of said vanes are provided with biasing means for urging the tip portions into sealing engagement with the annular wall liner means and/or said side sealing portions into sealing engagement with said respective end plates respectively.

14 A vane pump or motor device as claimed in claim 13, wherein the biasing means is a spring.

15 A vane pump or motor device as claimed in claim 13 or 14, wherein said radially outer sealing portion overlaps with each said side sealing portion.

16 A vane pump or motor device as claimed in any one of claims 11 to 15, wherein said side end plates are provided with working fluid inlet and outlet means.

17 A vane pump or motor device as claimed in claim 16, wherein said inlet and/or outlet means are provided with valve means to control the passage of working fluid into and out of the pump or motor device.

18 A vane pump or motor device as claimed in claim 17, wherein said valve means is a variably controllable valve means.

19 A vane pump or motor device as claimed in claim 17 or 18, wherein said valve means is in the form of a disc having at least one aperture forming a said inlet or outlet means.

20 A vane pump or motor device as claimed in claim 19, wherein said disc valve means is mounted on a valve means control shaft running through the centre of the rotor.

21 A vane pump or motor device as claimed in any one of the preceding claims, which is suitable for use as an engine or an internal combustion engine, and which is provided with four vanes on said rotor so defining four variable volume fluid chambers.

22 A vane pump or motor device as claimed in claim 21, wherein said four vanes define respectively the induction, compression, power and exhaust stages of a four stage internal combustion engine.

25 A vane pump or motor wherein two or more vane pump or motor devices as claimed in any one of the preceding claims are arranged in series such that a first motor acts to give the induction and compression stages and a second motor acts to receive compressed fluid and to give the power and exhaust stages.

23 A vane pump or motor device as claimed in claim 21 or 22, wherein there is provided fuel injector means and/or fuel igniting means.

24 A vane pump or motor device as claimed in claim 23, wherein the fuel igniting means is a spark plug or compression ignition means.

25 A vane pump or motor wherein two or more vane pump or motor devices as claimed in any one of the preceding claims are arranged in series such that a first motor acts to give the induction and compression stages and a second motor acts to receive compressed fluid and to give the power and exhaust stages.

26 The use of a vane pump or motor device as claimed in any one of the preceding claims, as an engine or an internal combustion engine.

27 A vane pump or motor device substantially as hereinbefore described with reference to the accompanying drawings.

28 The use of a vane pump or motor device substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9723429.8 **Examiner:** C J Duff
Claims searched: 1 - 28 **Date of search:** 30 June 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F1F(FD, FEA, FEV, FEY)

Int Cl (Ed.6): F01C, F04C

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2249139 A	(TECHFLY) Figs 3, 4	11-15
X	GB 2143279 A	(NIPPON) Whole document	1,2,4,5,7, 8
X	GB 2140088 A	(MITSUBISHI) Whole document	1,2,3 at least
X,Y	GB 2074653 A	(LUCAS) Whole document	X: 1-8; Y:11-15, 21-26
Y	GB 0954442	(EICKEMEYER) Page 6, lines 48 to 111	21-26
X	US 4479763	(SAKAMAKI) Whole document	1,2,4,5, 11-13

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.